Breadcrumb Microsatellite System to Enable Positional Stability of Cis-Lunar and L1 GPS Failsafe Network

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Introduction

The extant GPS system is threatened not only by jamming, but by anti-satellite weapons ranging from missiles to electrostatic induction EM weapons systems stationed in orbit. This has caused planners to begin work on a system which uses a combination of cis-lunar space well-beyond HEO in the hopes that GPS systems based farther away will avoid destruction by anti-satellites weapons currently employed by countries such as China.

A positional reference system is required to support that network, which would not be limited to cis-lunar space, but which would also have an L1 Lagrange component (as the moon is not always visible from any given point on Earth.) That positional reference system would serve to enable the Lagrangian Navigation System (LNS) satellites to have some idea of their own relative position so that its own thruster system could be used to make the needed corrections.

Abstract

Although GPS satellites placed at even greater distances from the Earth than that which are current accustomed can certainly provide GPS functionality given enough transmissive power on both ends in the event of a failure of the primary GPS system, objects sent to cis-lunar space and to the vicinity of the L1 Lagrange would be positionally unstable (particularly the cis-lunar space, which is not a Lagrange at all and does not lend itself to the positional stability of floating objects.)

Ironically, satellites dispatched to this area for usage in precision navigation would need to have a means of knowing their own position. Ordinarily, we would use interferometers on Earth’s surface to perform this task, but the extreme distances involved prohibit this in the case of LNS.

In order to achieve this, a series of micro-satellites would need to be deployed like breadcrumbs leading from a known stable geosynchronous High Earth Orbit to the position of the Lagrangian Navigation System. Each individual micro-satellite would be capable of interferometrically measuring the distance to neighboring micro-satellites and of compensation for lateral drift predicated upon frequency multiplexing prism-enabled optical reference.

Every 200 miles, a micro-satellite would be kept in a fixed position through this system of mutual positional awareness and position could be adjusted through the use of either photo-magnetic or the older ion-based thrusters coupled with stored solar energy.

In this way, the LNS satellites would be able to ensure that their position relative to the Earth is as fixed as possible.

As the Earth would be rotating, the relative position of these satellites relative to the surface of the Earth would be constantly changing, but in a predictable way. So long as the LNS satellites remain in a fixed position relative the L1 and cis-lunar space, respectively, the rotation of the Earth could be accounted for through the use of precision clocks. Interestingly, the rotational velocity discrepancies caused by major seismic events would come into play for the LNS as these can throw off sunrise and sunset times by as much as a second over the course of a year (throwing off indicated position by a much as several miles if not accounted for.)

Conclusion

Maintaining a functional LNS is logistically and technically complex and may not be the most efficient way to overcome the potential hazards posed by anti-satellite weapons. There is no reason to assume that anti-satellite weapons cannot reach the L1 Lagrange and there is no reason to assume we cannot defend HEO satellites given recent advancements in LASER-based missile defense. However, if one insists upon building a functional LNS, this sort of "breadcrumb" system would be needed in order to enable the LNS satellites to maintain the correct relative position.

The constantly changing position of the satellites, which are meant to be reference points, gravitational inconsistencies which would affect precision clocks and inconsistencies in the rotational velocity of the Earth would all introduce elements of instability to the system. The increased transmissive power required would necessarily mean that pings would either need to be less frequent or would need to be used judiciously in order to conserve power. The use of Reverse-LiDAR based optical navigation rather than precision-timing based navigation would be a near-necessity as potential jamming would need to be addressed even morseo with this system and given the new variables for which we must account, it would be useful to be able to eliminate the gravitational uncertainty inherent to precision-timing based approaches. As this would be an entirely new network, there would be no reason to use the more antiquated precision-timing based approach. Precision timing, however, would come into play when accounting for the rotation of the Earth.